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VARIATIONS OF GLACIERS. XVIII[1]

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The following is a summary of the *Seventeenth Annual Report* of the International Committee on Glaciers.[2]

THE REPORT OF GLACIERS FOR 1911

Swiss Alps.—The general retreat of the glaciers in recent years was interrupted in the last two years by the advance of more than eight glaciers; but all of these glaciers have begun to retreat again. The remarkable heat of the summer of 1911 caused very great melting at the ends of the glaciers and seems to have brought their advance to an end.

Eastern Alps.—Here we have conditions very similar to those of the Swiss Alps. The hot summer of 1911 caused a very marked elevation of the snow line and the slight advance noted in 1910 was checked, and practically all the thirty-five glaciers under observation were in retreat. One only seemed to be stationary. The glaciers this year give no indication that the general retreat, which has been in progress for some time, has come to an end. The snow line is higher and the lower ends of the glaciers are flattened out by melting.

Italian Alps.—Observations at various points on the Italian side of the Alps show that, with one or two exceptions, the glaciers are continuing to retreat. On the south side of Mont Blanc the changes are very slight and the glacier in the Allée Blanche has actually advanced about eight meters.

French Alps.—In spite of the very hot summer of 1911 the glaciers on the French side of the Mont Blanc chain show a tendency to advance, and there is a distinct thickening of the glaciers a short distance above their ends. The glaciers of the Maurienne continue to retreat but very slowly. The great heat of the summer of 1911 does not appear to have greatly affected the glaciers in the northwestern part of the Pelvoux massif and in the Grandes Rousses. The general retreat has apparently been stopped in these mountains. The accumulation of snow has been increasing and this has protected glaciers from excessive melting.

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[1] Earlier reports appeared in the *Journal of Geology*, III–XXI.

[2] *Zeitschrift für Gletscherkunde*, VII, 37–47, 191–202.

Swedish Alps.—The Swedish glaciers lie pretty far north. Of the five under observation, four are advancing and one is stationary.

Norwegian Alps.—The interior glaciers of the Jotunheim are retreating; only two out of twenty-seven observed show slight advance. In the Folgefon and the Jostegalsbrae, near the west coast, thirteen glaciers are advancing and sixteen retreating. In the more northerly regions we find nine glaciers advancing and two retreating. It is rather interesting to note that different parts of the same glaciers are retreating at different rates.

Russia.—A number of glaciers in the Caucasus and several in the Altai Mountains are distinctly in a phase of retreat.

REPORT ON THE GLACIERS OF THE UNITED STATES FOR 1912[1]

In Colorado, the Hallet Glacier shows a trifling expansion (Mills). Although the snowfall during the winter and spring was very heavy, no change was apparent in the length of the Arapahoe Glacier (Henderson).

Mr. F. E. Matthes, who has been engaged in mapping Mount Rainier, sends me the following information regarding its glaciers:

> According to the testimony of Joseph Stampfler, a guide in the Mount Rainier National Park, who has lived since early boyhood at Longmire, in the valley of the Nisqually River, the Nisqually Glacier in 1885 extended to the point now occupied by the bridge on the government road to Paradise Park. The glacier accordingly has made a retreat of one thousand feet since 1885. In that distance it has left no marked morainal ridges, and the inference is that its retreat has been a fairly steady one.
>
> The retreat of the glaciers has been marked during the last four years (1909–12). The Paradise Glacier, which prior to 1909 descended from an irregular rock bench about 250 feet high to gather again on the flat terrace below (elevation 6,100 feet), now barely reaches the terrace in a few places.

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[1] A synopsis of this report will appear in the *Eighteenth Annual Report* of the International Committee. The report on the glaciers of the United States for the year 1911 was given in *Jour. Geol.*, XXI, 423–26.

The ice cave in its front, formerly much visited by tourists, has disappeared. Joseph Stampfler states that the Paradise Glacier once covered the entire terrace to its very edge. He cannot fix the exact date when the glacier began to withdraw from the edge, but he knows that it must have been in the early eighties. This edge is now more than two thousand feet in front of the ice.

The névé line on the Cowlitz, Nisqually, Van Trump, Wilson, and Tahoma glaciers, situated on the southeast, south, and southwest flanks of the mountain, appears to lie normally at an altitude between 7,000 and 7,500 feet. During the abnormally dry summer of 1911 the névé line rose to 8,500 feet or higher. In certain places on the Paradise, Nisqually, and Van Trump glaciers old ice was exposed as high as 9,500 feet. On the Tahoma Glacier (southwest side) the ablation was less conspicuous.

Mr. Matthes has emphasized the fact that the summit of Mt. Rainier is not the principal reservoir of its glaciers, but that the cirques and even the flanks of the mountain collect more snow than the summit. This is due not only to their larger area but also to the fact that the snowfall reaches its maximum amount at a much lower altitude than the summit of the mountain.[1]

Professor Lawrence Martin sends me the following information regarding Alaskan glaciers:

Kenai Peninsula.—Spencer Glacier is said by A. W. Swanitz to be receding more rapidly than in 1911, on account of the artificial diversion of a glacial stream to the ice border.

Copper River.—The Allen Glacier, on the lower Copper River, upon whose stagnant, moraine-covered terminus the Copper River and Northwestern Railway runs for 5½ miles, is reported by Caleb Corser to have commenced to advance during the summer of 1912. It was thicker and more crevassed than in 1911; and in places formerly covered by moraine, blue ice appeared. The northern margin is said to have advanced a half-mile. The largest glacial stream on the northern side of Allen Glacier has left its former channel for a new course a mile farther west. It has increased greatly in volume, and shifts frequently, causing much trouble to the railway on the northern alluvial fan of outwash gravels.

Heney and Grinnell glaciers were still advancing slowly in 1912. Childs Glacier (presumably the northern margin) advanced 60 feet between July 15 and September 30.

Miles Glacier seemed to be advancing farther into the frontal lake than in 1911. On August 16, 1912, a sudden flood (perhaps from the draining of a glacier-margin lake) swept down the Copper River from Miles Glacier, raising the water level 12 feet at Childs Glacier bridge, and doing much damage twenty miles farther south.[1]

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[1] "The Undescribed Glacier of Mount Rainier," *The Mountaineer*, Seattle, V, 42-57; "The Glaciers of Mt. Rainier," *Appalachia*, XIII (1913), 24-27.

Wrangell Mountains.—Kennicott Glacier was unchanged from 1911 to 1912; the descriptions of the upper portion of this glacier and its tributaries in 1911 and 1912 by Miss Dora Keen, who ascended Mount Blackburn in the latter year, indicate no significant present-day activity. Chitina Glacier is said by Benno Alexander to have advanced between 1911 and 1912.

St. Elias Range.—The previously unexplored glacier system of the St. Elias Range between Mts. Logan and Natazhat was partly mapped in 1912 by the American Boundary Survey party under D. W. Eaton. The Chitina Glacier, whose chief tributaries are Logan Glacier from the southeast and Anderson Glacier from the northwest, is 3½ to 5 miles wide at the terminus. Logan Glacier is 45 or 50 miles long and 2½ miles wide. It probably originates near Mt. Logan on a through glacier divide connecting with the Seward Glacier of the Malaspina system. The lower portions of Logan and Chitina glaciers are covered with ablation moraine and forest, including trees at least one hundred and ninety-three years old. The heavy growth of coniferous forest along the margins of Logan Glacier shows that it has not been larger than now for several centuries. The photographs and descriptions by Mr. Eaton show that Logan Glacier commenced a spasmodic advance in 1912 which widened and crevassed the upper portions of the glacier; ablation moraine material fell into crevasses; the glacier advanced over alders, and marginal lakes were formed. This activity after nearly two centuries of stagnation is probably the result of avalanches due to the earthquakes of September, 1899, in Yakutat Bay, which is less than 80 miles distant (only 50 miles from the divide between Logan and Seward glaciers). A small tributary of Anderson Glacier was also advancing actively in 1912.

Mr. C. G. Quillian, commanding the Unites States Coast and Geodetic Survey steamer "Mc Arthur," went close to the western edge of the Malaspina Glacier in May, 1911. He reports a new bay in the ice at the western edge of the glacier; its position indicates that the Guyot lobe of Malaspina Glacier has receded many miles. The new Coast Survey map (Chart 3002, March, 1912) indicates that this recession is about 9 miles, but Mr. Quillian's estimate is only 2½ to 3½ miles. The discharging face of the glacier within the bay was 200 to 250 feet high.

The writer of this review has concluded, from the study of a map and drawing made by Vancouver in 1794 and from a story handed down by the Yakutat natives, that the sea in the old Icy Bay of Vancouver reached to the Chaix Hills at the base of Mt. St. Elias in 1794. This involves the probability that the seacoast was subsequently pushed southward by the advance of Guyot

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[1] For a detailed map of the lower Copper River glaciers see Lawrence Martin, "Gletscheruntersuchungen längs der Küste von Alaska," *Peterm. Mitt.*, LVIII, (1912, II), 78-81, 147-49.

Glacier, as was suggested in 1904 by Davidson. This advance of about 20 miles probably took place between 1847 and 1886. The ice front of the Guyot lobe practically maintained its advanced position at least from 1886 to 1909, and has since receded between 3 and 9 miles, forming a new Icy Bay, a little west of the old one. This results in the destruction of the Icy Cape salient of Guyot Glacier, one of the only two places where a tidal glacier entered the open waters of the Pacific Ocean.

The Canadian Boundary Survey party under N. J. Ogilvie found that Nunatak Glacier had receded about $\frac{1}{4}$ mile between 1911 and 1912.

Glacier Bay.—The same party measured a recession of $1\frac{6}{10}$ miles at Grand Pacific Glacier in Reid Inlet of Glacier Bay. This ice tongue receded at the rate of only about 1,500 feet a year in the twenty years before 1899. Since then it has retreated at the rate of over 4,300 feet a year from 1899 to 1906, 1,320 feet from 1906 to 1907, and approximately 3,300 feet a year from 1907 to 1911. Between September 2, 1911, when seen from a distance by the National Geographic Society's expedition under Tarr and Martin, and June 1, 1912, when visited and mapped by Ogilvie, this ice tongue retreated between $\frac{1}{4}$ and $\frac{3}{4}$ mile (according to accurate measurements by the Boundary Survey party, 14,520 feet in all from 1907 to June, 1912). In the two months from June 1 to August 1, 1912, there was a further unprecedented retreat of between one and $1\frac{4}{10}$ miles (5,000 to 7,425 feet). A portion of the terminus of Grand Pacific Glacier is now in British Columbia, so that the waters of Glacier Bay are partly Canadian. The following table summarizes the retreat of Grand Pacific Glacier:

Year	Amount, Feet	Rate per Year, Feet	Based on Observation by
1879–92	21,120	1,620	Muir, Reid
1892–94	2,500	1,250	Boundary Survey
1894–99	6,600	1,320	Gilbert and Gannett
1899–1906	30,360	4,337	F. E. and C. W. Wright
1906–7	1,320	1,320	Morse, Klotz
1907–11	13,200	3,300	Tarr and Martin
1911–12 (June)	1,320	7,320±	W. J. Ogilvie
1912 (June 1 to Aug. 1)	6,000±		

This recession of 15 to 16 miles in thirty-three years is unique. The acceleration of retreat immediately after the 1899 earthquakes may be only a coincidence, for the still greater acceleration of retreat since 1911 can be explained only by a marked deficiency in the snow supply, which may have begun years ago.

Arctic Alaska.—In the mountains north of the Yukon River small glaciers were discovered in 1911 by P. S. Smith[1] and by A. C. Maddren.

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[1] P. S. Smith, "Glaciation in Northwestern Alaska," *Bull. Geol. Soc. Amer.*, XXIII (1912), 566.

A general description of the glaciation of the Alaska Range has been given by Capps[1] so far as it is known. The greater development of glaciers on the southern slope of the range, as compared with the nothern slope, is ascribed to the greater snowfall and to the larger collecting grounds. The southern slope is about twice as long as the northern.

Tarr has reviewed the observations made on Alaskan glaciers and their variations. He emphasizes the influence of avalanches due to earthquakes in causing spasmodic advance of glaciers.[2] In association with Martin he has published details of the sudden advance of the Yakutat glaciers due to the earthquake of 1899[3] (see earlier reports of this series). Grant and Higgins have collected their observations on the glaciers of Prince William Sound and Kenai Peninsula (already mentioned in these reports) in a bulletin of the United States Geological Survey, with maps and illustrations.[4] Several other bulletins of the Geological Survey contain maps showing the location of glaciers, but the descriptions of the glaciers are very cursory.[5]

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[1] Stephen R. Capps, "Glaciation of the Alaska Range," *Jour. Geol.*, XX (1912), 415-537.

[2] Presidential address before the Association of American Geographers, *Science*, XXXV (1912), 241-258; and *Annals of the Assoc. of Amer. Geographers*, II (1912), 1-24.

[3] R. S. Tarr and Lawrence Martin, "The Earthquakes of Yakutat Bay, Alaska, in September 1899." *U.S. Geol. Survey, Prof. Paper No. 69*, chap. iv.

[4] *Bull. No. 526.*

[5] F. H. Moffit and Stephen R. Capps, "Mineral Resources of the Nizina District, Alaska," *Bull. No. 488;* Stephen R. Capps, "The Bonnifield Region, Alaska," *Bull. No. 501;* "The Yentna District, Alaska," *Bull. No. 534;* F. H. Moffit, "Headwater Regions of Gulkana and Susitna Rivers, Alaska," *Bull. No. 498.*